Polaron mobility in the "beyond quasiparticles" regime

Andrey S. Mishchenko
RIKEN Center for Emergent Matter Science (CEMS), Wako, Saitama 351-0198, Japan

Lode Pollet
Department of Physics, Arnold Sommerfeld Center for Theoretical Physics, University of Munich, Theresienstrasse 37, 80333 Munich, Germany

Abhishek Kumar
Department of Physics, University of Florida, 2001 Museum Road, Gainesville, FL 32611, USA

Dmitrii Maslov
Department of Physics, University of Florida, 2001 Museum Road, Gainesville, FL 32611, USA

Nikolay V. Prokof'ev
Department of Physics, University of Massachusetts, Amherst, MA 01003, USA

Naoto Nagaosa
RIKEN Center for Emergent Matter Science (CEMS), Wako, Saitama 351-0198, Japan; Department of Applied Physics, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113, Japan

In a number of physical situations, from polarons, to non-Fermi liquids, to Dirac liquids, one often faces a problem of computing particle mobility/conductivity when conditions for applicability of the kinetic equation approach are violated. The corresponding "beyond quasiparticles" (or "overdamped") regime is formally identified as a state in which an inelastic scattering time (computed formally within the standard perturbative approach) is exceeding the typical thermal energy of quasiparticles. We employ the Diagrammatic Monte Carlo method to study mobility of Frohlich polarons in the overdamped regime and discover two non-perturbative effects: a mobility minimum at $T \sim \Omega$ when coupling is strong (substantial delay in developing an exponential law at temperatures below the optical mode frequency $\Omega$ at intermediate coupling), and complete destruction of the Drude peak in frequency dependence. Both effects should be taken into account in interpreting mobility data in materials with strong electron-phonon coupling. Mobility of a Frohlich polaron as a function of temperature at strong coupling $\alpha = 6$ is shown to the left.